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A PREDACEOUS MITE PROVES NOXIOUS TO MAN.

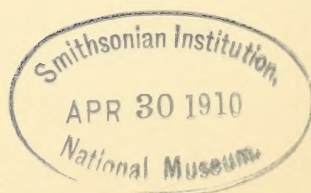
(*Pediculoides ventricosus* Newport.)

BY

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In Charge of Cereal and Forage Insect Investigations.

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(Pediculoides ventricosus Newport.)

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INTRODUCTION.

While the scientific and medical literature of European countries, and to some extent of Asiatic countries, contains numerous records of mites attacking man, it is difficult to determine, from a perusal of this literature, whether or not the mite *Pediculoides ventricosus* Newport, shown in its most active form by figure 1, has been concerned in these attacks. There is no particular reason why it should not have become noxious to man precisely as, and elsewhere than, in America, because it has doubtless, with its host insect, the Angoumois grain moth, *Sitotroga cerealella* Oliv. (fig. 3), been distributed in grains throughout the warm regions of the globe, wherever these grains have entered into international commerce. While there is a decided similarity between these attacks on man in Europe and America, the writer is unable to select, from the various instances recorded, a single one in which he can unhesitatingly say that this and not some other species of mite was responsible for such attacks. In many cases it is very clearly to be seen that other and very different species of mites have been involved in attacks of a similar nature, both in this country and in Europe. Here in America such troubles

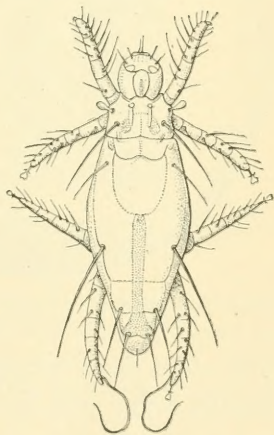


FIG. 1.—Adult female of *Pediculoides ventricosus*, before the abdomen has become inflated with eggs and young. In this condition the mite is nomadic and predatory. Greatly enlarged. (Redrawn from Brucker.)

have until recently been commonly attributed to "chiggers,"^a which inhabit neither the dried straw nor thrashed grain. The term "chigger" really includes a number of different kinds of mites, notably the young of *Trombidium* and other insects which inhabit grassy and weedy places and woodlands. This is why it is that people visiting such places are not infrequently attacked and suffer painfully therefrom. While our knowledge of the matter remained in this condition, the possibility of confusing the disease discussed herein with others of a much more serious nature was very great, but now that we understand the causes and know that these causes can be removed, and the physician enabled to distinguish it from an attack of "chiggers" and prescribe proper treatment, much of this danger

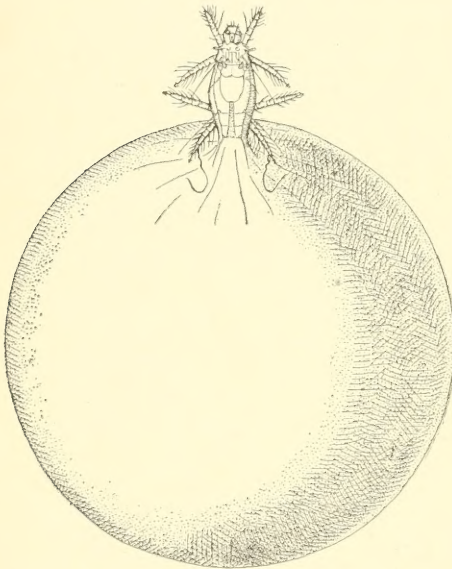


FIG. 2.—Gravid female of *Pediculoides ventricosus*. Greatly enlarged. (Redrawn from Brucker.)

and painful annoyance may be eliminated. There is also another point that must not be overlooked, namely, that this mite during its period of greatest activity is almost invisible to the unaided eye (see fig. 1). Not every practicing physician possesses a microscope that will enable him to detect the presence of the mite, even when abundant, but the pustules or wheals caused by it are sufficiently described in the paper by Doctors Goldberger and Schamberg and the one by Doctor Rawles to permit of identification. Later, when the gravid female mite (fig. 2) is distended with eggs and young,

it is more easily detected; but it is not in this state that it attacks human beings and is thus encountered by the practicing physician.

THE MITE BENEFICIAL IN AMERICA.

So far as the author has been able to determine, the first published record of the occurrence of this mite in America was by himself, and was included in a paper printed in the Twelfth Report of the State Entomologist of Illinois (pp. 150–151).^b While assistant to Dr. S. A. Forbes, state entomologist, he was directed to investigate serious injuries to stored grain by the Angoumois grain moth,

^a For a consideration of "chiggers," see Circular No. 77, Bur. Ent., pp. 1–6.

^b Published in Trans. Dept. Agr. Illinois, vol. 20, 1882.

Sitotroga cerealella (fig. 3), in southern Illinois, where Messrs. Halliday Brothers, of Cairo, growers and shippers of wheat, were at that time experiencing considerable trouble from the ravages of this grain moth, not only in their grain elevators but also in barges loaded with wheat to be shipped by river to New Orleans and thence exported by steamer.

It was during these investigations that this mite was discovered attacking the larvæ of the grain moth. As the original publication containing the author's observations is becoming more and more difficult to obtain, that portion relating to the occurrence of this mite is given herewith in full:

Pediculoides (Heteropus) ventricosus, Newport. About the 12th of October, 1882, a sack of wheat infested with larvæ of the grain moth was received from southern Illinois, which, for want of time, was put aside for future inspection. On the 13th

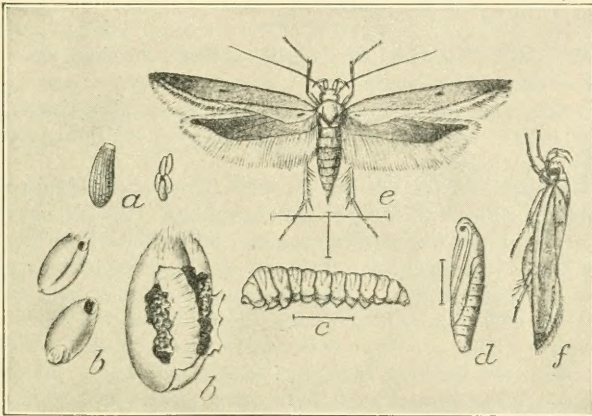


FIG. 3.—Angoumois grain moth (*Sitotroga cerealella*): a, Egg and egg-mass; b, larva in grain of wheat; c, larva; d, pupa; e, f, moth. Enlarged. (a, c-f, After Chittenden; b, original.)

of November, while examining the grains containing larvæ, I noticed, in a lot of fifty, three in which the worms were dead, and on them were numbers of globular, yellow objects, which proved to be a species of mite, *Pediculoides (Heteropus) ventricosus* Newport. Knowing nothing of the predaceous habits of these mites, and the limited literature at hand throwing little light upon the matter, I did not pay much attention to the fact of their occurrence until the 12th of December, when upon examining 100 grains with respect to the effect of heat on the larva, I found 14 of the latter infested by these mites.

In the meantime I had learned that this mite was known to be of predaceous habit, in both England and France, having been first discovered by Newport, in 1849, in the nests of *Anthophora retusa*, collected at Gravesend, England, and afterwards described by him under its present name. It had also been found in France, in 1868, by Jules Lichtenstein, of Montpellier, and described by him under the name of *Physogaster larvarum*. This gentleman found it in his breeding cages, which it so completely overran that, as he informs me, he could not for six months breed a single specimen of Hymenoptera, of Buprestidæ, or Cerambycidæ, or of some Lepidoptera.

If it has been found by any other persons than these, or in any other parts of the world, previous to its discovery here by me, I have not been able to find the fact recorded.

On December 31 and January 1, I examined 100 infested grains of this wheat, which had been continually kept in the laboratory since it was received, and found 32 per cent of the worms dead, infested by the mites.

While making these examinations I frequently threw the grains containing infested larvæ into a shallow glass dish, where they remained on my table until the warm weather during the latter part of February, when the temperature of the laboratory at night was much higher than it had been during the previous cold weather. The effect of the change was soon plainly to be seen. The contents of the dish began to swarm with newly developed mites, and a larva dropped into their midst was immediately attacked, and after that its life was of short duration. Larvæ placed at some distance from the dish suffered a like infection.

To test the matter I placed near the dish some weeds, in the pith of which some larvæ were hibernating, and in two days the mites had found and destroyed them. These young mites when first noticed are very minute, of elongate form, and extremely active, running about in search of larvæ; and when one is found they immediately puncture the skin and suck the juices.

In a day or two the posterior segments of the abdomen begin to enlarge, and this process continues until the inflated, bladder-like abdomen becomes ten or even twenty times the size of the cephalothorax.

During this time they have gradually lost their ambulatory powers, and remain stationary upon their victims. In the meantime changes equally wonderful have been going on within the abdomen.

Eggs are continually forming, and within these the young mites are as continually developing, passing through their entire metamorphosis, *which includes the acquisition of the fourth pair of legs* (an exceptional character among mites), within the abdomen of the mother, from which they make their way as fast as they reach maturity.

The females are quite prolific. I have counted frequently from 40 to 50 young and eggs within the abdomen, and believe that they produce even more. The mothers survive the birth of a large number, if not a majority, of the young. The male I have never found, and I am inclined to believe with Mr. Newport, that the species is parthenogenous.^a The minute size of these young mites admits of their free access to the larvæ of the moth, through the very small opening where this made its entry, and a single mite with its progeny would be sufficient to destroy it.

That this is very often the manner of attack is proved by the fact that grains in which the larva is badly infested frequently have no other break in the hull by which even a young mite could gain admission. Like the larvæ on which they subsist, their development is retarded or increased by the temperature, they being quite active at a temperature of 60° F.; but in colder weather able to remain within the abdomen of the parent for months in a dormant state, awaiting a rising temperature.

While, as stated, this was probably the first published record of the occurrence of this *Pediculoides* in America, the writer has since had reason to believe that it was present many years prior to this date; and, indeed, in the light of information that was obtained during the past year, 1909, it seems altogether probable that it not only occurred but proved noxious to man, in Massachusetts, as early as 1830.

The particular reference, however, to which attention is called may be found in the *Prairie Farmer* for the year 1845, page 216.

^a I have since observed the male, though only occasionally.

Much is here made of larvæ attacking the stems of wheat above the upper joint, and in connection therewith follows this significant sentence: "In one instance nine eggs were found in a single straw, one of which had just hatched." Also, in another journal, we are told that specimens of infested straw were forwarded to the Country Gentleman from Scipioville, N. Y., in 1879, which the sender stated contained eggs, besides larvæ and pupæ. In both cases the larvæ were almost beyond a doubt those of the greater wheat-stem maggot (*Meromyza americana* Fitch). According to my own observation, the mites attack the larvæ of *Meromyza americana* in stems of wheat, and one can not fail to be struck by the clearness with which the statements just given describe larvæ of this species in the stems of grain or grass being attacked by these mites, the gravid female of which has every appearance to the unaided eye of being a minute egg. It therefore seems not improbable that this mite was abroad over the country at the earlier date, 1845, which would antedate by several years the description of the species in England by Newport, who called attention to the occurrence of this mite as a parasite in the nests of a wild bee (*Anthophora retusa* L.) in a paper read March 5, 1850, before the Linnæan Society of London.^a

In the account given by Dr. T. W. Harris in the second edition of his "Insects Injurious to Vegetation," in connection with his discussion of the early occurrences of the barley jointworm (*Isosoma hordei* Harr.), there are two very significant statements that have until lately puzzled the writer greatly. On page 438, edition of 1852, he says:

In the summer of 1831, myriads of these flies [meaning the adult *Isosoma*] were found alive in straw beds in Gloucester, the straw having been taken from the fields the year before. An opinion at that time prevailed that the troublesome humors wherewith many persons were then afflicted were occasioned by the bites of these flies; and it is stated that the straw beds of Lexington, being found to be infested with the same insects, were generally burnt.

The second reference occurs on page 440 of the same volume, in which it is stated that "about eight years ago [which would be about 1844] some of these insects [again referring to the barley jointworm] that had come from a straw bed in Cambridge were shown to me. They had proven very troublesome to children sleeping on the bed, their bites or stings being followed by considerable inflammation and irritation, which lasted several days. So numerous were the insects that it was found necessary to empty the bedtick and burn the straw."

Now, to the writer it has always been puzzling that the adults of the barley jointworm, as they were described by Doctor Harris, should have been able to bite through bedticking and cause the

^a Description published in Trans. Linn. Soc. Lond., vol. 21, p. 95, 1853.

eruption described and yet not be able to gnaw through this cloth and make their escape, as every one who has reared these insects in confinement has witnessed their frantic efforts to escape as soon as they gnaw their way out of the straws. The mite *Pediculoides ventricosus* now furnishes as good an explanation of these attacks referred to by Harris as we can expect to secure, after a lapse of three-quarters of a century, with no possibility of obtaining actual proof in the case.

In 1884 the writer found this same mite attacking and destroying the wheat strawworm (*Isosoma grande* Riley) at Oxford, Ind., and in speaking of the occurrence of this larva and its parasites, he made this statement:

Curiously enough, during the time it occupies the stubble in the larval and pupal stages, it sometimes falls a victim to the mite *Pediculoides* (*Heteropus*) *ventricosus*, which enters the stubble from above after the grain is cut, but whose sense of discrimination is rather poorly developed, and it is finally victorious over the *Isosoma* larvæ, its parasites, and the predaceous larvæ of *Leptotrachelus dorsalis*.

The same year, and in the same locality, this mite was again encountered by the writer, attacking the greater wheat-stem maggot in wheat straw, and the remarkable resemblance of the gravid females to minute eggs was again noted. Since that time this *Pediculoides* has been reported by Mr. E. M. Ehrhorn attacking the larvæ of the peach twig borer, *Anarsia lineatella* Zell., in California.^a The same year Mr. Marlatt reported it as attacking the eggs of the periodical cicada, *Tibicen septendecim* L.^b The same year Dr. F. H. Chittenden^c stated that this mite attacked the larvæ of two species of bean weevil (*Bruchus quadrimaculatus* Fab. and *B. chinensis* L.) and destroyed them, often in great numbers. Still later, in 1904, Messrs. W. D. Hunter and W. E. Hinds, in Bulletin No. 45, Division of Entomology, page 107, called attention to its attack on the larvæ of the cotton boll weevil. In 1908 Mr. W. Dwight Pierce^d stated that this mite is a common weevil parasite in Mexico. In the same publication, page 42, he credited it with being parasitic, not only on the cotton boll weevil, *Anthonomus grandis*, but also on an allied species, the pepper weevil (*A. eugenii* Cano). Dr. A. D. Hopkins informs the writer that in his studies of forest insects he has encountered it attacking the larvæ of wood-boring beetles, and at one time, in West Virginia, it caused considerable mortality in his rearing cages, where he was attempting to rear wood-boring longicorn beetles (Cerambycidae) and barkbeetles (Scolytidae), precisely as experienced by M. Jules Lichtenstein in France.

^a Bul. 10, Div. Ent., U. S. Dept. Agr., p. 17, 1898.

^b Bul. 14, n. s., Div. Ent., U. S. Dept. Agr., p. 104, 1898.

^c U. S. Dept. Agr., Yearbook for 1898, p. 247.

^d Bul. 73, Bur. Ent., U. S. Dept. Agr., p. 30.

In the publication of Messrs. Hunter and Hinds previously referred to, some information is given relative to an attempt to use this mite artificially in overcoming the boll weevil. It has been experimented with quite extensively by Prof. A. L. Herrera and his assistants of the Mexican Commission of Parasitology, and upon his return from a trip to Mexico in the fall of 1902 Mr. Hunter brought with him, through the kindness of Professor Herrera, a supply of the parasites, from which others were reared for experimental work in Texas. This experiment, however, owing to conditions beyond the control of man, appears, fortunately perhaps, not to have resulted satisfactorily. One of the principal obstacles in this case seems to have been that, where the mites succeeded in establishing themselves, they were subsequently destroyed by the attacks of small ants.

These references show quite clearly the wide distribution of this mite throughout the United States and its great variety of host insects. We have, in later years, come to consider it a very useful parasite and one that is likely to attack almost any soft-bodied larva to which it can gain access and be secure from other predaceous insects and adverse meteorological conditions.

THE MITE PROVES NOXIOUS TO MAN.

As indicated in the earlier portion of this paper, either this or some other closely allied species has long been known to occasionally attack man and animals in Europe, when these are engaged in handling or come into contact with grain or straw infested by their host insects. The first instance of this character to be noted in America, however, has been communicated to the writer by Dr. Henry Skinner, of Philadelphia, Pa. It was about the year 1896, while Doctor Skinner was practicing medicine in Philadelphia, that the owner of a boarding house in one of the New Jersey suburbs of the city came to him in great distress, stating that the tenant and keeper of the boarding house, which accommodated about seventy-five persons, would not pay the rent thereon, and further stated that the tenant had been threatened with legal proceedings by the boarders, who had even suggested bodily injury. The occasion of all this trouble was an epidemic of a rashlike disease, the causes of which were suspected to reside in the mattresses of the beds occupied by the patrons of the house, because the occupants had been attacked by a very mysterious and aggravating skin eruption. The owner submitted straw dust and mattress débris taken from the suspected beds, and on examination of this Doctor Skinner found specimens of this mite. The house was promptly deserted by the boarders, none of whom, as it seems, escaped infection, and none of whom was

willing to return. The matter does not appear to have been further investigated.

In 1901 Jay F. Schamberg, M. D., of Philadelphia,^a published a short paper calling attention to and describing "An Epidemic of a Peculiar and Unfamiliar Disease of the Skin." In this paper Doctor Scham-

berg, who, besides being a practicing physician, is professor of dermatology and infectious eruptive diseases in the Philadelphia Polyclinic, described a number of cases that had been treated by him a few weeks prior to the publication of his paper. The eruption and its effect on the patient were briefly described and illustrated, but the causes instrumental in bringing about these attacks were still unknown to him; and, as several members of the same household were commonly affected, the disease was considered likely to prove contagious. The dermatitis, however, was not lost sight of, and in a paper contributed to the Public Health Reports Dr. Joseph Gold-

berger, passed assistant surgeon of the United States Public Health

FIG. 4.—Lesions caused by bites of the mite *Pediculoides ventricosus*.

In this case the eruptions are excessively large, blister-like, and sparsely placed over the body including the neck, while there are none upon the arms.

and Marine-Hospital Service, in cooperation with Doctor Schamberg,^b published the first exact information we have relative to the cause of these epidemics. This paper, so far as known to the writer, is the

^aPhila. Medical Journal for July 6, 1901.

^bPublic Health Reports, vol. 24, No. 28, July 9, 1909.

first publication in this country in which the attack of this mite has been followed up and its dermatological effect on human beings carefully studied and described. This paper of Doctors Goldberger and Schamberg may be briefly summarized as follows:

In the spring and summer of 1909 this peculiar eruptive disease became quite prevalent in Philadelphia and neighboring towns. An outbreak among 20 sailors upon a private yacht docked in the Delaware River attracted the attention of both the city and the federal health authorities. The Surgeon-General of the United States Public Health and Marine-Hospital Service delegated Dr. Joseph Goldberger, passed assistant surgeon, to proceed to Philadelphia for the purpose of making an investigation of the disease.

After examining the 20 sailors, who had been sent to a hospital, Doctors Goldberger and Schamberg visited the yacht whence they came and made a searching examination of the conditions on board. Their attention was directed to the fact that a number of new straw mattresses had been received and that the disease was con-



FIG. 5. -Lesions caused by bites of the mite *Pediculoides ventricosus*. In this case the eruptions are almost the reverse of those shown in figure 4. They are much smaller, more densely placed, and confined more to the lower portion of the back, there still being very few on either neck or arms.

fined to those who had slept upon these mattresses or had placed their clothes upon them. Eleven officers and members of the crew who did not sleep upon the new mattresses remained entirely free of the disease.

At about the same period information was received concerning an eruptive disease prevailing among the sailors of four other boats, plying along the Delaware River. Investigation disclosed the fact that these boats had also received new straw mattresses, and, furthermore, that only those were attacked who slept upon the mattresses or otherwise came in contact with them.

In addition to these cases among sailors, Doctors Goldberger and Schamberg examined or received authentic information concerning seventy other cases of this disease occurring in twenty different households in Philadelphia and its vicinity.

In practically every instance they were enabled to determine that the patient had either recently slept upon a new straw mattress or had freely handled the same. Where only one person in a household was affected, it was found that he was the only one to occupy a bed supplied with a new straw mattress. They were able to trace all of

the incriminated mattresses to four leading mattress manufacturers. Figures 4, 5, 6, and 7, from photographs by Doctor Schamberg, show the condition of some of the victims and illustrate different forms of the eruption.

Careful investigation warranted them in excluding from consideration the ticking of the mattresses and the jute or cotton topping contained therein. The cause of the disease was, therefore, circumscribed to the straw. Repeated inquiries elicited the information that all of the manufacturers had received, at the time the disease-pro-



FIG. 6.—Lesions caused by bites of the mite *Pediculoides ventricosus*.

In this figure the eruptions are still more minute, covering the entire body, including the arms and neck, the hair having been removed from the neck to show their diffusion even on the base of the head. The lesions are also less swollen than shown in figure 5.

ducing mattresses were made up, wheat straw from a dealer in Salem County, in southern New Jersey. One manufacturer had used straw from this source exclusively in the affected mattresses, while in another case the straw had come from southern Indiana.

Finding of a parasite. Doctors Goldberger and Schamberg sifted the straw from a mattress through the meshes of a fine flour sieve upon a large piece of plate glass covered with white paper. Close scrutiny of the siftings under strong electric illumination soon detected some slight motion. The moving particles were touched with

a needle moistened in glycerine and transferred to a glass slide. Search with the microscope disclosed the presence of a mite of very minute dimensions. The mite was identified for them by Mr. Nathan Banks, expert in Acarina of the Bureau of Entomology, United States Department of Agriculture, as very close to, if not identical with, the *Pediculoides ventricosus*.

In order to demonstrate experimentally the etiological relationship of the suspected straw mattresses, Doctor Goldberger exposed his bared left arm and shoulder for one hour between two mattresses. At the end of about sixteen hours, a number of characteristic lesions appeared upon the arm, shoulder, and chest. Later, three volunteers slept upon the mattresses and each one developed the eruption at the end of about the same period.

Doctor Goldberger later took some of the sifted straw, divided it into two portions, and placed it in two clean Petri glass dishes. One of these was applied for one hour to the left axilla of a volunteer. At the end of from sixteen to seventeen hours the characteristic eruption was present in the area of the left axilla to which the Petri dish of straw siftings had been applied.

The second portion of the straw siftings in a Petri dish was exposed to the vapor of chloroform under a bell jar with a view to killing any insect or acarine that might be present. These siftings were then applied to the right axilla of the same volunteer to whose left axilla the untreated siftings had been applied. The chloroform evidently destroyed in the siftings the agent that was producing the eruption, for no lesions appeared after the application of the chloroformized siftings.



FIG. 7.—Lesions caused by bites of the mite *Pediculoides ventricosus*. In this case the effect is entirely different from that shown in any of the other figures, the lesions not only covering the body, including the arms, but extending over the face and forehead; they are more sparsely placed but accompanied by very large, irregular, inflamed patches. This figure illustrates the liability of this dermatitis being mistaken for other dangerous, contagious diseases, like smallpox and spotted fever.

Doctor Goldberger, further, removed from some straw siftings five minute mites, and, placing them in a clean watch crystal, applied the crystal to the axilla of another volunteer. At the end of about sixteen hours following this application five of the characteristic lesions appeared on the area to which the mites had been applied. (See fig. 8, from drawing by F. H. Wilder.)

INFLUENCES CONTROLLING THE EXCESSIVE ABUNDANCE OF PEDICULOIDES.

It will be noticed that Doctors Goldberger and Schamberg made no attempt to discover the underlying causes for the enormous numbers of these mites inhabiting the mattresses involved in their investigations,



FIG. 8.—Lesions caused by bites of the mite *Pediculoides ventricosus*.
About natural size.

that problem coming properly within the realm of entomology. When the writer took up this subject with the view of finding out the causes for such an abundance of these mites, Doctors Goldberger and Schamberg very kindly placed at his disposal everything in their possession relating to this epidemic, including the mattress which Doctor Goldberger had himself used in experiments with this mite, carried out by

him at the Hygienic Laboratory in Washington. Doctor Schamberg was equally kind in placing at his service all of the material, notes, and photographs in his possession.

Almost at the commencement of the investigation, Dr. William Royal Stokes, of the Maryland state board of health, informed the writer that a similar but less extensive epidemic had shortly before been noted in Baltimore. This he kindly described as follows:

The matter was brought to my attention by several persons, who came to the head of the department and complained of the skin eruption described. They stated that a number of people in a suburban hotel were similarly affected, but I do not remember the number at this late date. These persons volunteered the information that they had all been sleeping on some new straw mattresses, and that all of the persons similarly affected had used these mattresses.

I saw Doctor Gilchrist, the clinical professor of dermatology at Johns Hopkins University, yesterday, and he gave me the following description of the one case which he saw at the health department. I saw two other cases which corresponded with these in a general way.

"The eruption consisted of about 1,000 wheals, or erythemato-withicarial spots, or papulo-withicarial lesions. As in the description in the reprint of Doctors Goldberger and Schamberg, of the United States Public Health and Marine-Hospital Service, they varied in size from a lentil seed to a finger nail, and are round, oval, or irregular in shape. No vesicles or pustules were seen. The eruption was on the neck, chest, abdomen, and back, and also on arms and legs. Itching was present, and all lesions showed evidences of scratching."

Besides this, there were several cases reported to the writer from northern Maryland, where farmers in running their wheat through a fanning mill had been simultaneously troubled by a very similar or identical eruptive disease of the skin. In another instance, a thrasher-man engaged in feeding the unthrashed grain into the cylinder of



FIG. 9.—Adult of jointworm (*Isosoma tritici*). Much enlarged. (From Howard.)

the thrashing machine was also affected by a disease of the skin, entirely unfamiliar to the attending physician, who could not classify it with any urticaroid dermatitis known to him. After the writer's experience of previous years, it seemed impossible that this *Pediculoides* should become sufficiently abundant to cause this dermatitis without there being an excessive abundance of some host insect or insects affecting either the straw or the grain itself. Naturally, the studies made by him in 1882 led him to suspect that the Angoumois grain moth (*Sitotroga cerealella*) might be responsible for the abundance of the mites. Then, too, the fact that it attacked the wheat-straw worm (*Isosoma grande* Riley) in wheat straw led him to suspect that, as this particular species is not known to occur in the vicinity of Philadelphia, while its near relative, the joint worm (*Isosoma tritici* Fitch) (fig. 9), does occur more or less abundantly over the

eastern part of the country, this latter species, too, might perhaps be involved.

With a view to finding out something of the abundance of the grain moth in New Jersey, from which State was obtained most but not all of the straw entering into the mattresses mentioned by Doctors Goldberger and Schamberg, the writer applied to Dr. John B. Smith, state entomologist, for information. In reply Doctor Smith was kind enough to send the writer an advance copy of the report of his department of the New Jersey Agricultural Experiment Station for the year 1908, and from this publication it was learned that during the summer of that year, owing to favorable weather conditions, this moth developed rapidly in the field and there was great damage to wheat among those farmers who delayed thrashing until September or later. Furthermore, a very large percentage of the wheat crop gathered that year became useless for milling purposes, and so general was the infestation that grain from some localities was entirely barred at mills except when ground for the owner. Some further investigations carried on in eastern Pennsylvania revealed a very similar condition of affairs. It was the straw of 1908, coming mostly from New Jersey, but a small part of it from Indiana, that entered into the mattresses, from the use of which came the epidemic in and about Philadelphia.

In order to settle these points, Mr. V. L. Wildermuth, of the Bureau of Entomology, was instructed to examine the straw in the mattress placed at the writer's disposal by Doctor Goldberger. After a day and a half of careful search, only five straws affected by the joint-worm were found. This seemed to entirely eliminate this species from consideration in connection with this particular epidemic. There were, however, many wheat heads remaining attached to the straw, and these heads contained a great many kernels, the contents of which had been eaten out by the larvæ of the grain moth. Moreover, these eaten kernels contained great numbers of the dead bodies of *Pediculoides*. That the Angoumois grain moth was the cause of this damage to the wheat was still further proved by the emergence of an adult moth from these eaten kernels on November 15. The larvæ of this moth infested the kernels of wheat before the latter were thrashed. Many of these infested kernels remaining in the straw were included in the material going into the manufacture of these mattresses. The greater portion of the living larvæ of the moth would develop to adults during May or early June, thus cutting off the food supply of these mites. The mites would therefore very naturally swarm among the straw and, making their way through the cloth covering of these mattresses, attack anything that gave promise of furnishing food and preserving them from starvation. It seems that starvation is the final outcome, however, for, as already

stated, no trouble is experienced in using the mattresses after a certain period, which period probably indicates the termination of the life of the mites infesting the straw. It therefore did not seem necessary to seek further for the primary cause of this eastern epidemic of dermatitis, the center of which seems to have been in and about Philadelphia.

A WESTERN EPIDEMIC OF THE DERMATITIS.

While the problem of the epidemic in the East was apparently solved, some of the wheat straw involved therein had come from Indiana, and during the last few years an outbreak of the jointworm (figs. 10 and 11) had been gathering force throughout Ohio, Indiana, and southern Illinois, until during the summer of 1908 very serious damages occurred. Investigation of the insect during previous years had shown that the outbreak really began in the more elevated portions of Virginia, in the upper Shenandoah Valley, in West Virginia, and in eastern Ohio, as early as 1904, afterwards advancing broadly to the westward.

During the summer of 1908 there came to the Bureau of Entomology from this section of the country a great number of complaints of serious skin trouble among people engaged in thrashing grain that had been stored for some time in barns, and in some localities it had become difficult to secure help to thrash under such conditions. Also the same disorder was encountered by those who used this straw for the purpose of filling bedticks, or as a substitute for felting under carpets, and in one case berry pickers had been attacked when such straw had been used as a mulch for berry plants. This straw came from a field that had been seriously damaged from jointworm attack in 1908. In one instance a carload of wheat straw was shipped to Pittsburg, Pa., and six men engaged in unloading it were attacked



FIG. 10.—Effect of jointworm attack on wheat straw in field. Note enlargements and distortions. Reduced. (Original.)

by some skin eruption, and the horses used in hauling this straw after it was unloaded also suffered from what was seemingly the same disorder. Perhaps the following from a correspondent of the Bureau of Entomology, residing in southern Ohio, will give a fair idea of the situation on many farms in that section of the country:

About four years ago a parasite was found when thrashing wheat out of barns. It seemed to affect the victims almost as soon as they got into the mow. The men began to scratch themselves, generally on the neck and on the arms (inside) opposite the elbow, and on the body, back and front. The parasites raised welts such as you describe and spread as you indicate. They have spread to such an extent that farm hands dread them and will not change work with neighbors unless they thrash in the field. Here of late they are found in wheat straw in the barns, especially if baled. Last week a farmer brought me baled wheat straw that seemed to be alive with them. They attacked every one that went into the barn, and one of my horses that was perspiring from effects of a drive was simply covered with little knots or swollen places and bit and rubbed himself continually. I had to have the straw hauled out and burned and the barn disinfected. The farmer stated that they were so thick in the shed that contained the straw that he had to keep all stock out of the shed.

Many other similar letters from towns in Ohio were received by Doctor Schamberg, particularly from Zanesville, Columbus, Vincent, Springfield, etc., where the affection is popularly believed to be due to "chiggers." A physician from the last-named town stated that



FIG. 11.—Female *Isosoma* in act of depositing egg in stem. About life size. (Author's illustration.)

in the fall of 1908 during harvest and thrashing time he saw in Washington County some 87 cases of the disease in question. It affected the harvesters and thrashers. This spring he observed 38 cases from contact with straw ticks refilled with straw of last fall's crop. The disease is said to have been more prevalent last year (1908) than ever before. Information has come from Columbus, Ohio, that potters who used straw for packing crockery ware have been so badly attacked at times that the entire force of packers has been off duty. Many

times a whole carload of straw has been so affected that the use of it has been abandoned. In Springfield, Ohio, it is said that the disease was so bad a year or two ago in the lowlands west of the city as seriously to hamper the progress of the construction of a large sewer; this, however, might have been due to attack by other mites. In Zanesville, Ohio, the potters have been obliged to abandon the use of straw and employ "prairie hay" for packing purposes.

Doctor Schamberg was also informed by a physician of Pittsburg that a young woman patient had suffered from an affection closely resembling if not identical with the one under consideration each time that she had assisted in emptying cases of dishes packed in straw. Both the physician and the patient had come to believe that something in the straw was the cause of the eruption.

Indeed, so nearly did the territory from which these complaints came to us coincide with that affected by the jointworm that it created the suspicion, not only among those engaged in the investigations, but even among farmers themselves, that there must be some connection between the two phenomena. Very many of these cases were brought to the notice of practicing physicians, but the latter were at a loss to account for the prevalence of this dermatitis, many of them supposing it to be some species of rash that was more or less contagious, the exact nature of which they did not know. The liability of confusion with other vastly more serious contagious diseases, notably smallpox, was of course very great.

Among these physicians was Dr. Lyman T. Rawles, of Hometown, Ind., who, in May, 1909, undertook a careful study of a number of cases of this dermatitis that had come under his personal observation, as well as those of some of his associates. Doctor Rawles's investigations were very carefully made, and the results are exceedingly valuable for the reason that, in the case of this western epidemic, he was able to trace the cause of the skin eruption to the mite (*Pediculoides ventricosus*) and follow this back to the host insect, the wheat jointworm (*Isosoma tritici*).^a It clears up the obscurity surrounding the cause of this epidemic in the Middle West, a section throughout which the Angoumois grain moth never occurs in excessive abundance excepting in grain that is kept in store, and then only in the more southern portion of Indiana and Illinois.

In May, 1909, Doctor Rawles found in his practice that a very strikingly strange skin disease presented itself in his own and the

^aOwing to an unfortunate misunderstanding, for which no one connected with these investigations is responsible, Doctor Rawles did not receive a proper determination of the mite involved in his studies of the dermatitis. The entomological nomenclature in his paper, printed in the Journal of the Indiana State Medical Association, August, 1909, should therefore be corrected by substituting *Pediculoides ventricosus* for *Ditropinotus aureoviridis* wherever the latter name occurs.—F. M. W.

surrounding country in epidemic form. Through the press notes it seemed to be quite general over the northern part of the United States, limiting itself to the wheat-growing sections.

The people generally affected were farmers and those living in small villages or towns where straw is used in beds, under carpets, and around stables to bed stock. Horses and cattle have been seen with a skin disease almost identical with that seen in man. The following incident led him to an investigation as to the probable etiology:

A family had cleaned house, refilled the straw ticks of their beds, and placed fresh straw under the carpets, and in about one week the family had developed this peculiar skin disease. In the beds was found a small black fly (*Isosoma tritici* Fitch) about the size of an ordinary gnat, which at first it appeared to be, but closer observation revealed that it was not of the gnat family. Upon examination of the straw it was found that a large number of the straws were perforated; these perforations were through the wall in the region of the joint, generally about 2 inches from the joint. The perforations were about the size of a small pinhole and ranging in number from ten to thirty in a straw. Upon examining a section of this straw the small black fly was found under many of the openings through the walls.

Several flies were examined to ascertain if they possessed a piercing proboscis, and while observing one which had just been taken from under the sheath of the straw, through which there was no perforation over the fly, a small mite was observed crawling over the dead body of the fly.

Placing the bodies of several of these flies under the microscope and using a one-fourth-inch objective and a No. 5 eyepiece, it was found that on nearly all flies over which the wall was intact a small mite could be detected, these varying in number from two to four mites to each fly. Upon furthering the observations it was found that the dermatitis lasted after the flies had been observed and exterminated.

The following experiments were tried to prove whether it was the fly or the mite that was the etiologic factor in producing the dermatitis.

Six live flies were taken, upon which no mites could be found; these were placed under a watch glass and bound upon the right arm, leaving them in contact with the skin for three hours. Upon the left arm four dead flies, on which living mites had been observed, were placed under a watch glass and left in contact with the skin for three hours, after which the glasses were removed and results awaited. The right arm showed nothing. Upon the left arm there appeared within twelve hours four small wheals, the character and evolution of which are later described.

To further the experiments some fresh lesions of patients were scraped and the scrapings examined microscopically, and two of the mites were found in the scrapings.

Itching is the most prevalent and first symptom to attract the attention of the patient. It is most persistent and intense during the after part of the night. At about the time the itching was most intense there appeared an urticarial eruption, accompanied, in severe cases, with general systemic symptoms, such as rise of temperature from 99 to 102; in one case the temperature rose to 103.8; the pulse rate is accelerated to 100, or as high as 110—in one case to 130. Other symptoms were intense headache, anorexia, nausea, in some cases vomiting, and a mild form of diarrhea. In severe cases some complained of general joint pains and backache; in these cases the urine was examined and albumin in small amount was found, but no casts or blood. When the acute symptoms disappeared, so did the albumin.

Many patients who suffered from mild cases complained of nothing aside from the intense itching. If all straw was removed from the beds and house, the symptoms would subside in one or two days and completely disappear in a few days more.

The lesion, which is typical of the disease, is the urticaria vesiculosa. The urticarial lesion varies in size from that of a split pea to that of a penny; it is surrounded by a pinkish halo, varying in intensity of color from a pale pink to a most bright pink. The "hive"-like lesion is at first blanched, but later becomes a rose-red color. It is elevated about 1 or 2 millimeters above the skin surface, and is surmounted by a small vesicle containing a whitish fluid marking the place of inoculation. The vesicle is about 1 or 2 millimeters in diameter and elevated about 3 millimeters above the surface of the urticarial lesion. As the lesion grows old it goes through the process of evolution: (1) It is blanched and has a central vesicle; (2) it is rose-red and the vesicle may become a pustule; (3) it generally recedes to the skin level with scab formation, due to the scratching; (4) it leaves a brownish or greenish-yellow or purple spot on the skin surface. In debilitated patients the markings look not unlike faded indelible-pencil marks. (This was noted in a patient suffering from pulmonary tuberculosis.) These discolorations may last for several weeks.

The anatomical location of the lesions is generally the back, sides, and abdomen, and less frequently the arms and legs. The neck has very few lesions; the face, hands, and feet have very few or none.

The number of lesions depends upon the number of mites, ranging from very few to thousands; in some cases the back and abdomen have been almost a solid mass of lesions—new lesions on the tops of old lesions, so having lesions in all stages of development.

Later investigations carried out by Mr. Wildermuth, at Lafayette, Ind., during December, 1909, and January and February, 1910, show that where straw is kept in masses, as in stacks and barns, the mites literally swarm through the straw, and as soon as an *Isosoma* or its parasites attempt to gnaw their way out through the cells in the

straw, the mites enter and kill them before they are able to enlarge the opening sufficiently to enable them to make their escape: indeed, not more than 5 per cent succeeded in escaping.

As this represents fairly well the conditions of straw in spring and early summer when it is used for the manufacture of mattresses and on the farms for the filling of straw ticks and as a substitute for felting under carpets, the great number of cases of this dermatitis occurring over the country is not at all surprising, and the indications for the season of 1910 are more favorable for an increase than a decrease in the trouble.

OBSCURITY SURROUNDING THE OCCURRENCE OF THIS SKIN DISEASE.

The exact nature of this eruptive disease was not at all understood by the medical profession throughout the country. In southwestern Virginia thrashermen suffered from the same disorder, but attributed it to "chiggers" (fig. 12), and local physicians, though skeptical, were themselves unable to correctly diagnose or to account for the trouble. As the disease is not serious and passes away in the course



FIG. 12.—*Leptus americanus* at left; *Leptus irritans* at right. Highly magnified. (After Riley.)

of time without leaving the patient in any way permanently injured, it seems to have been passed over by medical men without investigation, excepting by the physicians whose publications have just been cited. Among the people themselves the eruption was probably more frequently attributed to

attacks of "chiggers" or a "rash" than to any other cause, and it is quite likely that this common erroneous interpretation of the origin of the eruption has prevailed generally throughout the country, including the upper Shenandoah Valley in Virginia, where the jointworm was abundant as far back as 1904. It was, consequently, rather unfortunate that, with the beginning of this disorder, an institution in one of the States involved should publish a newspaper bulletin crediting the epidemics of this eruption to the attack of "chiggers," and, furthermore, that a second press bulletin, accentuating the first, should have been issued and sent to every newspaper in the State and from these copied into other newspapers throughout the country. Thus it was that an entirely erroneous impression was magnified and still further diffused.

In order to determine the likelihood that those handling straw in the wheat field will be attacked by the small red mites often mistaken for "chiggers" that abound in the harvested grain at this time,

Mr. Wildermuth, of the Bureau of Entomology, made a number of experiments. In no case was he able to provoke an attack from these red mites, probably *Tydeus* sp., even when they were confined upon the skin of his bare arm. On the other hand, examinations of straw from various points in Ohio and Indiana have revealed the presence of *Pediculoides* in the cells occupied by the jointworm. This seems to entirely eliminate "chiggers" from these investigations because these were probably not present and there does not longer appear to be any doubt that *Pediculoides ventricosus* is to be charged with causing the epidemic of this dermatitis. The cause of its own excessive abundance lies in the outbreaks of the Angoumois grain moth upon the grain in the East and the jointworm in the wheat straw in the Middle West. Therefore "chiggers" do not appear to figure as a cause in such epidemics.

LIGHT THROWN UPON OTHER PROBLEMS.

These investigations have illustrated very nicely the extent to which the solution of one entomological problem will at the same time also solve other problems more or less closely allied to the original one. The light thrown upon the cases of eruption noted by Doctor Harris in connection with the barley jointworm has already been explained. The present outbreak of the jointworm in the Ohio Valley probably originated in the upper Shenandoah Valley of Virginia, extending northward and westward throughout West Virginia and eastern Ohio. When investigation of the insect was taken up in 1904 a parasite, *Ditropinotus aureoviridis* Crawford, was also noted in excessive abundance, but for some reason it did not overcome the jointworm. This phenomenon has been noted continually. Since that time it has been a perpetual enigma to the writer why it was that with such an abundance of its natural enemies the jointworm should continue to spread and increase in destructiveness. Now, however, that we know that this predaceous mite is able to develop through a series of years in such immense numbers in connection with the jointworm, the matter comes nearer a solution. *Ditropinotus*, as well as some other parasitic enemies of the jointworm, emerge in early July from eggs that were previously placed in the cells occupied by the jointworm. As soon as the adult parasites emerge they at once oviposit in cells containing jointworm larvæ of the same generation from which they themselves developed. The puncturing of these cells by the ovipositor of these parasites, particularly *Ditropinotus*, opens a way for the entrance of this microscopic mite, and, once inside of the cell, it will destroy everything therein, whether it be jointworm or parasite. Thus the predaceous mite has prevented the other parasites from controlling the jointworm because it has continually checked the increase of other parasites.

In the light of the foregoing, it would appear that the only way to evade the disorder among human beings caused by this mite lies in preventing the occurrence of these two destructive grain insects which are responsible for the abundance of the mite itself. There is, therefore, a double incentive for the farmer to use every effort to prevent the occurrence of these pests in his fields. In many fields in Ohio Mr. Wildermuth found that more than one-half of the straws had been attacked by jointworms, and the damage resulting from their attacks amounted to a considerable percentage of the farmers' wheat crop. (See fig. 13.) In addition to this—and we now know that this

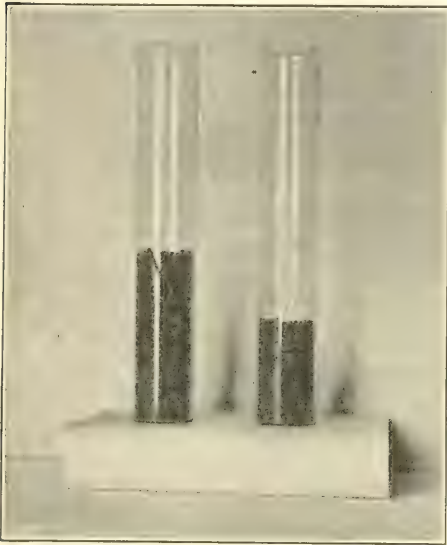


FIG. 13.—Reduction in yield of wheat attacked by jointworm (*Isosoma tritici*). The tube at left contains yield from 100 heads from uninfested straws; tube at right contains yield from 100 heads from infested straws. (Original.)

mite is generally present—his own family and employees suffer the annoyance of this dermatitis and also those who attempt to use mattresses into which the infested straw has entered. Thus people hundreds of miles away, unaware of the presence of these mites in mattresses, are caused not only great aggravation but intense suffering through their use.

DEVELOPMENT OF THE MITES.

The investigations carried out during the winter of 1909–1910 by Mr. Wildermuth reveal the fact that a period of from six to an indefinite number of days elapses between the time a female emerges from the abdomen of the mother until it

produces young. This depends upon temperature.

For a temperature of from 90° to 100° F., six days elapses; for a temperature of from 80° to 90° F., seven days elapses; for a temperature of from 70° to 80° F., nine days elapses; for a temperature of from 60° to 70° F., thirteen days elapses, and for a temperature of from 50° to 60° F., twenty-eight days elapses.

With temperatures lower than 50° F. it is doubtful if the mites would develop. The periods required for the development of different females subjected to the same temperature are very uniform. (For instance, in temperatures of from 70° to 80° F. nearly every female produced young in exactly nine days.) The life of the mites

varied from eighteen to an indefinite number of days—forty-three days was the maximum age for those kept under the lower temperatures. The number of young produced by a single female varied considerably and variation was greater among individuals under like conditions than among those under variable conditions. The number varied from just a few to 270. From 3 to 8 males were usually produced, there being two exceptions to this: In one instance, when the temperature was between 70° and 80° F., 26 males were produced and in another case a large number. The firstborn in many cases were males. The largest number of young produced during any one day by a single female was 52.

The ideal temperature for rapid development and the production of the maximum number of young was from 70° to 80° F. The abdomen of the female reaches its maximum size in about five days. The mite is omnivorous, preferring smooth larvæ to hairy ones. A young mite can not enter a closed *Isosoma* cell. Mites can live only a short time without food—less than a day in all cases observed. Copulation occupies only a few minutes, the males rarely leaving the surface of the abdomen of their mother. In the laboratory a single *Isosoma* pupa or larva will sustain a female up to the time she produces young and continue to support her progeny for from twenty to twenty-eight days. In the field, or under natural conditions, one pupa would probably furnish food for live mites for approximately the same length of time, as in one experiment a pupa furnished sufficient food for a month. The mites can be kept alive by subjecting them to a low temperature and development checked for an indefinite time. When attacking human beings they do not bury themselves in the skin and remain there as do the "chiggers."

PREVENTIVE AND PROTECTIVE MEASURES.

Throughout the territory involved in the eastern epidemic of this dermatitis, which was due to the excessive abundance of the Angoumois grain moth, the evidence recently obtained by the writer has been overwhelmingly to the effect that where wheat was thrashed as promptly as possible after harvest and directly from the shocks in the field, almost no occurrence of this grain moth, without which there would be no mites, was observed by millers and others handling the thrashed grain. On the other hand, when hauled from the field and placed unthrashed in the barn, the damage from this pest has varied up to nearly 50 per cent, and has so affected the crop as to cause its rejection by millers, except where ground on the farmer's order. Here, then, is a means of protection for people who use or handle wheat straw grown in this section of the country.

In Ohio, Indiana, and Illinois, where the mite causing this dermatitis has increased enormously on account of the prevalence of the

jointworm, wheat placed in the barn before thrashing has been found much more likely to produce epidemics of this disorder, although the difference between wheat thrashed in the field and in the barn is not so striking as where the trouble results from abundance of the grain moth.

A careful study of a large number of wheat fields in central Ohio by the Bureau of Entomology has shown that the infestation from the jointworm during the season of 1909 varied from 1 to 95 per cent. Here, too, the mite was found generally in the cells in the straw occupied by the jointworm larvæ. It has been found that in central Ohio September sown wheat is much more seriously affected by the jointworm than that sown in October, and also that the infestation is worse in both cases on poor soil than on that of an average degree of fertility, and still less on good soil. The infestation is invariably worse in fields on which wheat had been grown the previous year, and in fields lying adjacent thereto. Fall-plowed fields showed the least infestation of all. It appears, therefore, that moderately late-sown wheat on good soil and on land not devoted to wheat the previous year nor lying adjacent to such fields, escapes with the least injury, and that less difficulty with the dermatitis is experienced where wheat has been thrashed from the field and as soon as possible after the grain was harvested. As the jointworm winters over in the stubble, where this can be burned during fall, winter, or spring, the destruction of both the pest and the mite in the field will be complete. Where this can not be done, much good may be accomplished by raking over last year's stubble fields in the spring and burning the stubble thus collected. So important are these measures that practicing physicians might almost include them with their prescriptions for this painful skin disorder.

SUGGESTION TO CORRESPONDENTS.

In order that this mite may be further studied with reference to its direct relation to man, all requests for information and correspondence relating to dermatological matters should be addressed to Dr. Joseph Goldberger, passed assistant surgeon, United States Public Health and Marine-Hospital Service, Hygienic Laboratory, Washington, D. C. All correspondence relating to entomological and agricultural matters connected with epidemics of this skin eruption should be addressed to the Bureau of Entomology, Department of Agriculture, Washington, D. C.

Approved.

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *January 11, 1910.*

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